THE APPLICATION OF VALUE ENGINEERING IN SOIL IMPROVEMENT (PROJECT OF PELINDO III TELUK LAMONG SURABAYA)

Wendi Boy[1*], Muhammad Agung Wibowo[2], Miftahul Huda[3]

[1]Civil Engineering Program,
University of Dharma Andalas Padang, Indonesia

[2]Civil Engineering Program, Engineering Faculty,
University Diponogoro - Semarang, Indonesia

[3]Civil Engineering Program, Engineering Faculty, University of Wijaya Kusuma Surabaya, Indonesia

**wendi@unidha.ac.id*

Absract— This study was conducted on soil improvement works development Pelabuhan Indonesia III projects, Teluk Lamong Surabaya. The aim of the study was to obtain the optimization of the acceleration of soil consolidation using preloading with prefabrication vertical drain (PVD) and prefabrication horizontal drain (PHD). The method used in this study is the optimization of value engineering methods, which generally consists of phases: information, creativity, analysis, development and recommendation. The study concluded that the consolidation of the soil with alternative preloading system using landfill with γd = 1.91 kg/m3 and using PVD/PHD brand Geowork type MW- 408/Geowork type SD 100 X 20 with a distance of 80 cm is a method the most optimal soil improvement. This alternative produces a faster consolidation of 53 days from the scheduled time and cost savings of about Rp 1.77 billion from the planned start-up costs.

Keywords— value engineering, consolidation, preloading, PVD/PHD.

I.Introduction

Teluk Lamong Container Yard Owned Indonesian Harbour (Pelindo III) Surabaya is Built as an Extension Of The Harbour Of Tanjung Perak Surabaya As Well As Anticipation Over Capacity In The Second Largest Port In The Indonesia. Development work that has been done among others include; causeway construction, with an area of 70,000 m2, construction of the causeway, with an area of 34 704 m2 and the construction of the container yard of 20,000 m2. While The Scope Of The Work Carried Out One Of Them Is The Work Of Existing Embankment On Soft Soil. In one pile of work in soil mechanics phenomena that often cause problems are the geotechnical consolidation, especially on soft ground conditions. soft ground generally has a shear strength and low permeability and compressibility are large, so that the time required for a longer consolidation. one of the ground improvement techniques that are often used in soft soil problems is the initial loading (preloading), the use of Prefabricated Vertical Drain (PVD) and prefabricated horizontal drain (PHD).

Preloading the selection of material type and spacing using PVD/PHD to accelerate the consolidation of an important part in the implementation of soil deposits. preloading by selecting the type of material, the use of the type of PVD/PHD and PVD mounting distance / PHD most optimal field conditions, is predicted to get the optimization in terms of time, quality and cost of implementing employment projects. therefore, this study is very important and much needed especially to realize the optimization of the cost of implementation of ongoing projects.

2. LITERATURE REVIEW

2.1 Definition of Value Engineering

Value Engineering (VE) is a management technique by using a system which is an organized effort directed at the analysis and identify functions that are not essential and eliminate costs that are not useful to achieve the desired function with a total minimum cost while maintaining security (safety), performance (performance), reliability (reliability) and quality (quality) of the construction product / project. The application of value engineering (VE) in the construction industry has resulted in substantial savings in terms of materials and construction, cost and time [1]. Society of American Value Engineers, defines that the Value Engineering is a business organized systematically and applying a technique that has been recognized, which is a technique to apply a product or service which aims to meet the required functions at the lowest price [2].

2.2 Basic Principles of Value Engineering

The main purpose of creating a product basically is that the product created can be sold quickly, with maximum benefit and can give satisfaction to the consumer. Thus the designers of the product should not create the functions of the product as well as the use of excessive production ultimately useless, and the price is high. So the idea should be developed with a starting point of [3] :

1) The cost savings, which is using the lowest possible cost without reducing the functionality and quality of a product.
2) Time, which use the time as best as possible, it is intended to use the minimum time to get maximum results
3) Materials, using the material that truly meets function and quality.

2.3 Value Engineering Job Plan

The work plan (job plan) is a systematic approach of value engineering that is directed to carry out value engineering, including the implementation of the results. The work plan is also a key determinant of the success of the study [4]. Approach work plan engineered this value all stages in the studies carried out, ranging from the identification of items of work of the entire project, finding an item of work with the potential to unnecessarily high costs, to look for new alternatives creatively to display the same functionality as desirable as design previous [5]. The work plan is also helpful in determining the parts that have high costs compared with similar facilities [2].

2.4 Phases of Value Engineering

Some phases are commonly used in the value engineering [6], namely: 1) Information Phase , 2) Creative Phase, 3) Analysis Phase, 4) Development Phase and 5) Recommendation Phase .

1) Information Phase ; The goal is to obtain the background of the project and defines the functions, a way to get all the facts, make sure costs, defining the function. Gets support techniques required data according to the specific job, divides the problem into functional groups. Questions to be answered: what and how the project and its cost, what is the function and value function [7].

2) Creative Phase: The goal: to get an idea of design alternatives. Technique: collecting ideas and creative thinking and questions to be answered. Another question is what can fulfill the function
3) Analysis Phase : The objective: to evaluate the basic functions, evaluating new ideas, making comparison of alternatives and develop alternative chosen and prepare a report of recommendations. Technique: evaluating the basic functions of comparison, comparing the methods, products and materials, define life cycle cost and recommendation. Questions to be answered : what is the most optimal alternative to be able to display the function.
4) Development Phase : Taking into account the results of the analysis including the most optimal cost to be recommended.
5) Recommendation Phase : Provide recommendations on the results of the analysis and development related to product the most optimal alternative by considering the function and reliability of alternative products is proposed.

2.5 Theory of Settlement

The pace of consolidation are lower in saturated clay with low permeability can be increased by using vertical drainage (vertical drain) that shorten the track drainage in clay. Consolidation calculated due to the radial horizontal flow which causes the dissipation of excess pore water pressure more quickly, while the vertical drainage of very little significance. In theory, the greater the reduction in the final consolidation is the same, only the rate of the decline is different.

Reduction or settlement occurs when the soil material receives a load on it. To determine which settlement occurs, in addition to unknown parameters of the soil and the depth of the groundwater level, should also be known to the history of the land itself. Settlement due to the consolidation of the foundation soil can be calculated using the following equation [8].

1) for normally consolidated soil (Soil Nc)

$$Sci = \left[\frac{Cc}{1+e_o} \log\left(\frac{p'_0 + \Delta p}{p'_0} \right) \right] xHi \text{............}(1)$$

2) for a more consolidated soil (Soil Oc)

a) if po + p <p'c

$$Sci = \left[\frac{Cs}{1+e_o} \log\left(\frac{p'_0 + \Delta p}{p'_0} \right) \right] xHi \text{.....}(2)$$

b) if $p_0 < p'_c < p_0 + \Delta p$

$$Sci = \left[\frac{Cs}{1+e_0} \log \frac{p'_c}{p'_0} + \frac{C_c}{1+e_0} \log \frac{p'_0 + \Delta p}{p'_c} \right] xHi \text{.......}(3)$$

Where :

Sci = compression consolidation of the soil layers to be reviewed, the i-th layer
Hi = a thick layer of soil to-i
eo = initial void ratio of the soil layer to-i
Cc = compression index of the i-th layer
Cs = inflate the index of the i-th layer
Po '= effective vertical soil pressure of a point in the middle layer of the i-th ground under the weight of its own above that point in the field (efectif overburden pressure)
Pc ' = effective overburden pressure past, consolidation voltage effective in the past.

Due to the burden of preload that were above the effective vertical soil pressure of a point layer in the field occurred in the middle, and because of the depth and weight of the unit varies land perlapis then be computed by the equation:

Po '= ɣ. H .... (4)

Additional information: generally soft ground in Indonesia can be considered a rather consolidated soil more, with a price:

Pc = Po '+ f .... (5)
Where :
f = the greatest fluctuations in groundwater levels, with price fluctuations in the groundwater,
Δp = Extra vertical voltage i point being simulated (in the middle layer of the i-th) due to the addition of the load.

3) Time consolidation
The length of time consolidation according to Terzaghi (Kristiyanti, 2010) can be searched by the equation: $t = \frac{Tv.(H_{dr})^2}{Cv}$ ....(6)
Where :
t = time of consolidation.
Tv = time factor.
Hdr = length of drainage.
Cv = coefficient of consolidation

3. Research Method
The research methodology is a process and plan of thinking to solve the problem, ranging from preliminary research, the discovery of the problem, observation, data collection both written references and direct observation in the field. Perform data processing to draw conclusions on the problems studied [2]. The object and location of the research conducted on soil improvement works Pelindo III development projects, Kalimireng Surabaya. The steps that need to be done in the research process, including:

1) The preparation phase, namely : to collect or find the data of the project, conducted a survey to the project site to get a general overview of the field and to study literature either through journals, books library, internet, or other materials that can be used as additional reference materials and knowledge.
2) Data research, grouped into two, namely a) primary data: is the source of data obtained directly from the original source (of the project) / basic data used in the analysis Value Engineering in the form of data generated through interviews and surveys directly on the project, b) secondary data: is the data to support that can be used as input and the reference in the analysis value engineering, including data on unit price list and analysis of labor, materials data or the building materials used, labor data, and other data which can be used as a reference in analyzing the value engineering.
3) Data collection method : a) primary data, namely ; by means of direct surveys on consultants and executors handling the project. It also made observations directly to the project site, b) secondary data, namely : by doing direct survey at agencies or companies are considered to be interested, including the companies : materials/building materials, consultants, contractors, contractor personnel work as well as other companies that can be used as reference material.
4) Analysis of data: data that has been collected to analyze the value engineering to produce the existence of a cost savings or cost saving. Value engineering analysis conducted five stages, namely: a) information phase, b) creative phase, c) analysis phase, d) development phase, and e) recommendation phase.

4. Discussion
4.1. Information Phase

Soil improvement on Causeway construction work (area of 70,000 m2), construction of roads Causeway (area 34 704 m2) and construction of container yard (20,000 m2) using the method of preloading and PVD / PHD is based on the initial planning to have the data such as Table 1.

Table 1. Data Area Soil Improvement Works, Preloading and PVD/PHD

No	Description	Specifications	Remarks
1	Total Area Employment	304.704 m^2	Project Phase I
2	Volume Excavated	soil depth t = 3 meter	Project Phase I
3	Type of Soil Existing	Soft soil	
4	Preloading	γ_d = 1,85 kg/m^3, γ_{sat} = 2,099 gr/cm^3	Existing soil
5	PVD	Diamater = 10 cm, distance = 115,5cm. Merk Geowork, Type MW-408 pattern original triangular shape	original Planning
6	PHD	Following specification PVD Merk : Geowork, Type MW-408	original Planning
7	Poject Scheduling	21 months (without soil improvement)	Project Phase I
8	Time consolidation	24 weeks (180 days)	Original Schedul

Area soil improvement have 3-meter-deep excavation volume of approximately 304 704 m2. Preloading for the acceleration of the planned consolidation trapisium shaped with the condition and size as in Figure 1. Land preloading taken from local soil with dry density γd = 1.85 kg / m3, and the density of wet ɣsat = 2.099 gr / cm3. To accelerate the consolidation and reduction in land used PVD method and PHD.

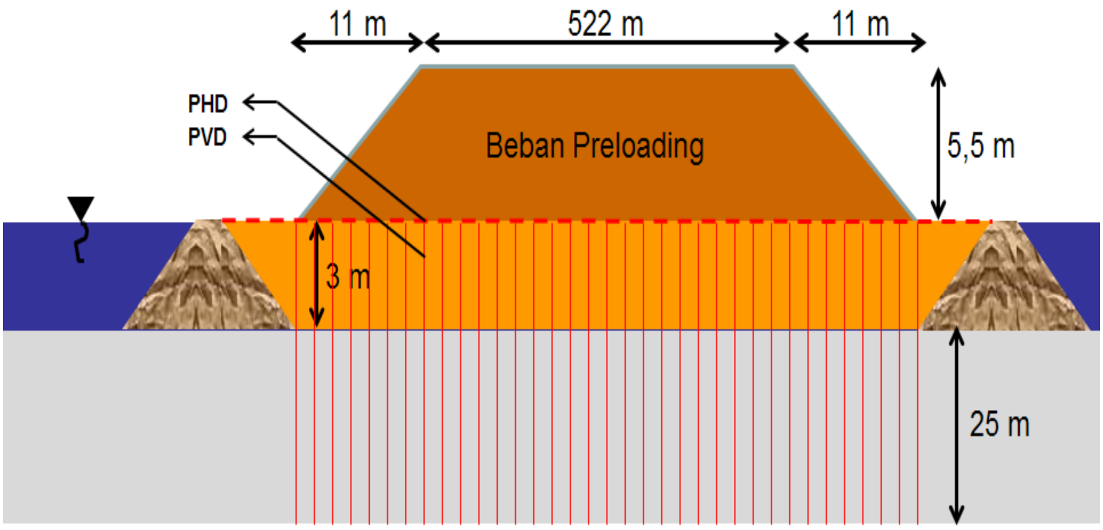

Figure 1. Transverse Pieces Soil Improvement Preloading

Table 2 is the average SPT test result data extracted from a ten point by sampling at locations pebaikan ground (secondary data, 2014)

Table 2. Technical Data of Test Results Mean SPT

Depth	Layer	SPT	Pore	Density	Coef. of Consolidation	Compression Index
z (m)	Ho (m)	(N)	e_o	γ (Kg/m3)	Cv (Cm2/s)	Cc
3	3	-	1.454	1.64	0.00097	1.500
6	3	2	1.622	1.59	0.00076	1.227
9	3	3	1.614	1.59	0.00077	1.278
12	3	2	1.622	1.59	0.00076	1.227
15	3	11	1.497	1.73	0.00104	1.500
18	3	13	1.478	1.74	0.00105	1.620
21	3	15	1.460	1.81	0.00110	1.710
24	3	15	1.460	1.81	0.00110	1.710
28	4	18	1.437	1.87	0.00118	1.830

4.2 Creative Phase

Based on the theory of soft soil characteristics, consolidation and settlement process is strongly influenced by time. Therefore we need an alternative preloading material whose weight is heavier types that exist around the project site in order to provide greater pressure on existing land, so that the consolidation process can be faster. Another alternative is to set the type and spacing PVD and PHD sedemikaian in order to obtain the most optimal space to get the most rapid consolidation process. Of the two alternatives are possible occurrence of an acceleration in employment pengurugan and construction works that are therein so will result in the acceleration of the entire project work. The creative phase can be explained in detail in Table 3.

Table 3

Alternative Use Preloading and Space PVD / PHD

No	Description	Design Alternative (1)	Design Alternative (2)
1	Tanah Preloading	Existing soil	Around the project soil
		γ_d = 1,85 kg/m^3,	γ_d > 1,91 kg/m^3,
2	PVD	D = 10 cm, S = 115,5 cm	D = 10 cm, S = trial and error
		Merk Geowork, Type MW-408,	Merk Geosistem, Type CT-D822,
		Price Rp 16.700,- /m^2	Price Rp. 17.200,- / m^2
		(include installing + tool)	(include installing + tool)
3	PHD	Following PVD distance	Following PVD distance
		Merk/Type : Geowork SD-100 X 20,	Merk/Type : Geosistem, CT-100 X 20,
		Harga Rp 17.200,- / m^2	Harga Rp 17.900,- / m^2
		(include installing + tool)	(include installing + tool)

Based on the material specification PVD / PHD on the market, chosen PVD / PHD alternatives that have better quality than the original planning material with a relatively cheaper price. Comparison of material specifications PVD / PHD original plan and an alternative design can be seen in Table 4.

Table 4. Original and Alternative Material Specifications PVD and PHD

No	Specification of Material PVD	MERK : GEOWORK	MERK : GEOSISTEM
		TYPE : MW-408	TYPE : CT-D822
1	Structure	Non Woven Geotextile	Non Woven Geotextile
2	Material	Polyster(PET)	Polyster(PET)
3	Pore Size	75 < Aos	63 < Aos
		≤ 90	≤ 75
4	Permeability	1.7 x 10-4 m/s	2.5 x 10-4 m/s
5	Grab Strength	259.64 N	504.24 N
6	Type	Corrugated	Fishedcore

References

[1] Rompas, Asrini Novita ; Tarore,H; R. J. M. Mandagi and J. Tjakra. 2013. Penerapan Value Engineering Pada Proyek Pembangunan Ruko Orlens Fashion Manado.Jurnal Sipil Statik Vol.1 No.5, April 2013 (335-340) ISSN: 2337-6732.

[2][6] Pontoh M. M, H. Tarore, R.J.M. Mandagi, G.Y. Malingkas. 2013. Aplikasi Rekayasa Nilai Pada Proyek Konstruksi Perumahan (Studi Kasus Perumahan Taman Sari Metropolitan Manado Pt. Wika Realty). Jurnal Sipil Statik. Volume 1 No.5,Hal.328-334

[3] Rumintang, A.(2008), "Analisa Rekayasa Nilai Pekerjaan Struktur Gedung Teknik Informatika UPN"Veteran" Jatim".Jurnal Rekayasa Perencanaan,Vol4, Feb.2008

[4] Marzuki, Puti Farida. 2007 . Makalah Rekayasa Nilai : Konsep dan Penerapannya di dalam Industri Konstruksi

[5] Yetty H., 2004. Aplikasi Rekayasa Nilai pada Proyek Konstruksi , Studi Kasus Proyek Pembangunan Gedung Keuangan Negara Manado, Skripsi, Fakultas Teknik Unsrat, Manado.

[6] Saptono, A. Analisis Penentuan Bangunan Atas Jembatan dengan Metode Rekayasa Nilai. http://matarancabuaya.files.wordpress.com/2011/08/contoh-proposal.pdf. 23 April 2012.

[7] Labombang, M. 2007. Penerapan Rekayasa Nilai (Value Engineering) pada Konstruksi Bangunan, 5(3), 147–156. Manggala.

[8] Kristiyanti, Dian. 2010. Perencanaan Lapangan Penumpukan Peti Kemas Di Terminal Peti Kemas Semarang. Tugas Akhir. Program Studi Teknik Sipil Institut Teknologi Sepuluh Nopember. Surabaya.